STATE OF IDAHO
Department of Fish and Game

Joseph C. Greenley, Director

U.S. National Marine Fisheries Service
P.L. 88-309 Projects

Grant No. 04-5-208-23
Project 1-106-R Segment 1

EVALUATION OF "QUALITY" ANADROMOUS SMOLT PRODUCTION TECHNIQUES

1 July 1974 - 30 June 1975

by

Donald R. Anderson, Jr.
Fish Hatchery Superintendent I

October, 1975

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ABSTRACT:

During the period from 1 July 1974 to 30 June 1975, we made two steelhead smolt releases and one spring chinook smolt release. The steelhead smolt releases included 140,000 Age II fish released in April 1975, and 89,000 Age I fish released in May 1975. The spring chinook smolt release took place in September 1974, and consisted of 350,000 Age I smolts. We made all releases directly into Hayden Creek at the hatchery outlet.

In addition to the fish released at Hayden Creek, we reared 400,000 spring chinook fingerlings for the Decker Pond project near Stanley, Idaho. The program for Decker Pond was financed by Dingell-Johnson funds.

Four adult steelhead returned to the Hayden Creek trap in May 1975. In March 1975, we received 732,000 eyed steelhead eggs from the Skamania Hatchery near Washougal, Washington, for incubation and rearing at Hayden Creek.

From July to September 1975, 151 spring chinook returned to the adult trap at Hayden Creek. The spawning of 55 female chinook resulted in 218,000 eggs.

A steelhead feeding experiment contrasting Oregon Moist Pellets to dry diets yielded additional information about raceway rearing of steelhead fingerlings.

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GENERAL HATCHERY OPERATIONS:

As in past years, our 1974-75 summer steelhead rearing program was based on spring releases of Age I and Age II steelhead smolts. Our objective is to identify the relative advantages and disadvantages of both age-class releases. Within each rearing regime we worked to maximize the percentage of smolts released by varying water remperatures, feeds and rearing durations.

We obtain the earliest steelhead eggs possible and hatch them in Heath stack-type incubators. At button-up, we move the fry to the raceways where they rear until they reach ponding size of 300-450 fish/kg. After ponding, these fish are fed by automatic feeders around the perimeter of the 0.2 ha dirt ponds. The fish rear in the ponds until the following April when we release them for emigration to the ocean (Fig. 1).

Our spring chinook rearing program is supported by September shipments of eyed eggs from Rapid River Hatchery. We incubate the eggs through the winter and move the fry to the raceways in February or March. By May, the fish have reached ponding size and are moved to one of the dirt ponds for rearing until the October release date.

In 1974-75, we also produced 400,000 chinook fingerlings for Decker Pond near Stanley, Idaho. The costs of this program were funded by the Dingell-Johnson program.

Our facilities for rearing both summer steelhead and spring chinook at Hayden Creek include ten Heath incubator stacks, two 61 x 1.2 m raceways and two 0.2 ha dirt ponds. Two water supplies consisting of 13 C (55 F) constant temperature spring water and varying temperature creek water service ponds, raceways and incubator stacks. We maintain an adult holding complex including ladder, trap and sorting pens.

By controlling the water temperature in the incubator stacks we can either slow or speed development of eggs or sac-fry. This enables us to select the times for moving the fry to the raceways which, in turn, allows us to control the time of ponding. By using this technique, we maintain both ponds in continual production with either steelhead or chinook occupying the facilities. The raceways are also in continuous use except for 2 months in the winter before the chinook are ready to be moved from the incubators.

Our production for 1974-75 was 249,000 summer steelhead and 350,000 spring chinook smolts. In addition, we made fry plants coincidental to grading and also supplied small numbers of fish for experimental purposes to both Idaho State University and the University of Idaho.

STEELHEAD REARING:

South Pond - 1973 Brood Year - Released April 1975

We released 140,000 Age II steelhead from the south pond 3-7 April 1975. The fish averaged 23.1/kg and 166 mm total length (Fig. 2). Total poundage released was 6,051 kg (13,340 lb). At the time of release, we carried 230,000

Figure 1. Steelhead smolts being weighed out of the outlet trap for release directly into Hayden Creek.

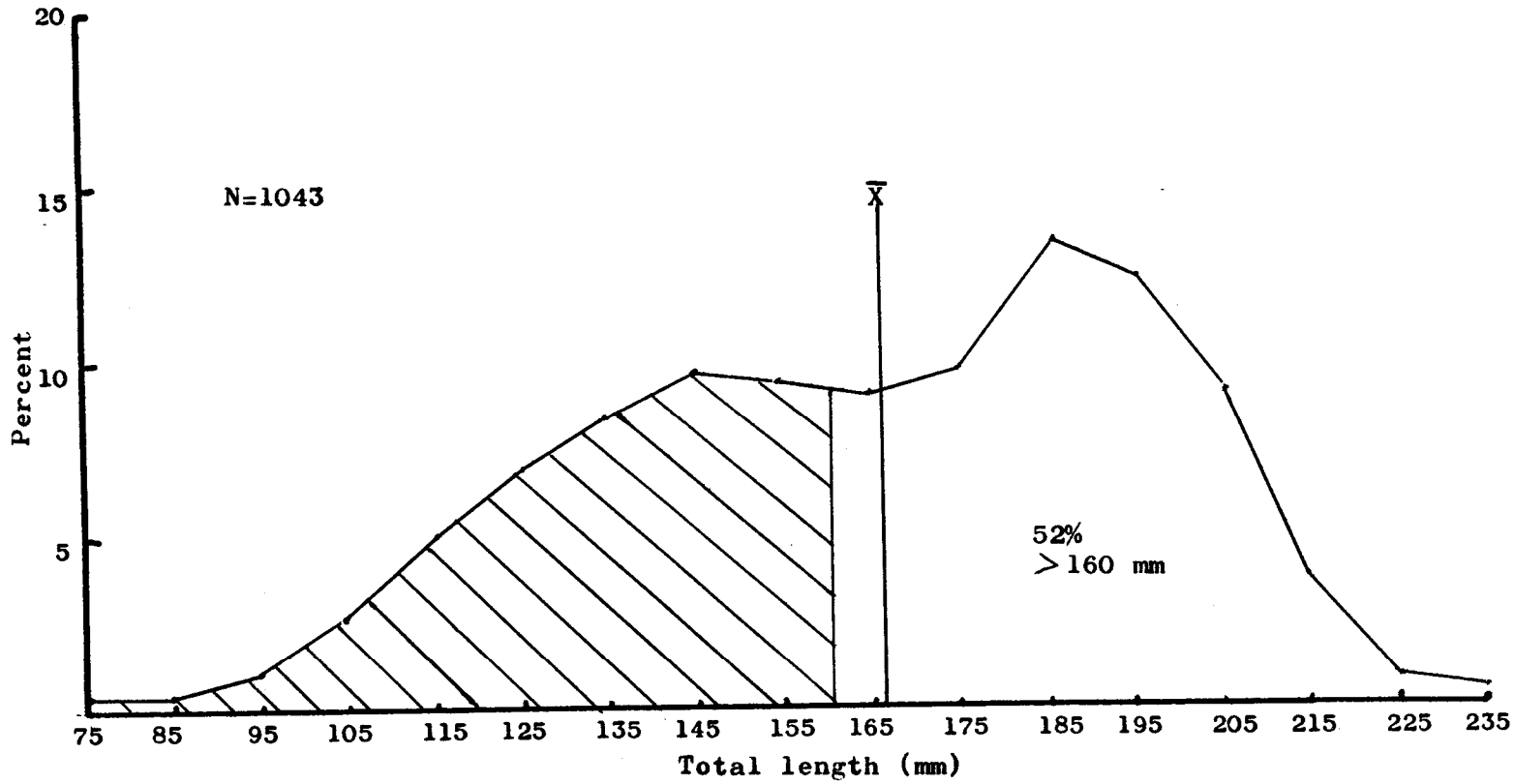

Figure 2. Length frequency of Age II steelhead released from south pond, April 1975.

fish on the hatchery records; therefore, we lost 45% from ponding in early December of 1973 to unobserved mortality, possibly cannabalism and/or escape.

These fish originated partly from adult returns to Hayden Creek and partly from an eyed egg shipment from Dworshak National Hatchery. We graded these fish prior to ponding but at release they showed a length distribution from 70-230 mm. We classed 52% of the fish as smolts, 6% as precocial males and 42% as sub-smolts below 160 mm. Seaward emigration was good except for the precocial males.

North Pond - 1974 Brood Year - Released May 1975

We released 89,000 Age I steelhead from the north pond 4-6 May 1975. These fish were from early April egg takes at Dworshak National Hatchery received at Hayden Creek as eyed eggs. They were held in straight spring water 11-13 C (52-55 F) throughout the rearing cycle. We graded the fish and ponded only the top grade in early October 1974. At release they averaged 156 mw and 27.9 fish/kg (Fig. 3). We classed 48% as smolts, 160 mm or larger, and 52% as sub-smolts. We saw no precocial males in our samples. Similar to the south pond, our total release represents 637 of the number being carried on our hatchery records, leaving 37% unobserved mortality.

Early in April, we released 10,500 steelhead before deciding to hold them for one more month in an effort to gain growth before the fish started to the ocean. We also estimated that 10,000 smolts escaped over the drum screen as they tried to begin emigration during April.

During April, we observed an outbreak of Bacterial Hemorrhagic Septicemia. Literature cites that the causative agent as of the genus Aeromonas which reportedly builds to high levels in accumulated excrement on pond bottoms. When we initially released in early April, we distributed this accumulation apparently allowing the fish to come into contact with the bacteria and causing the disease. We successfully treated the fish with terramycin-laced feed.

Raceways - 1975 Brood Year - For Release Spring 1976

Raceway rearing at Hayden Creek is beginning to emerge as the "make or break" phase of the steelhead rearing cycle. If we can rear the fish to 90 mm or larger by the end of September, we can expect to release 160 mm smolts the following April. This year we received eyed summer steelhead eggs in mid-March from the Skamania Hatchery near Washougal, Washington. These extremely early eggs resulted from selective breeding, over the past 14 years, of early-ripening adults. We moved the resulting 710,000 fry to the raceways in late April, giving us a month headstart over last year's steelhead and nearly 6 weeks over previous years.

We held the fish in straight spring water throughout the raceway phase and fed recommended levels of dry diet to the south raceway and Oregon Moist Pellets to the north raceway. We administered prophylactic treatments of Purina 4X and formalin monthly to prevent outbreaks of Bacterial Gill Disease and infestations of the external gill parasites Costia and Tricodnia.

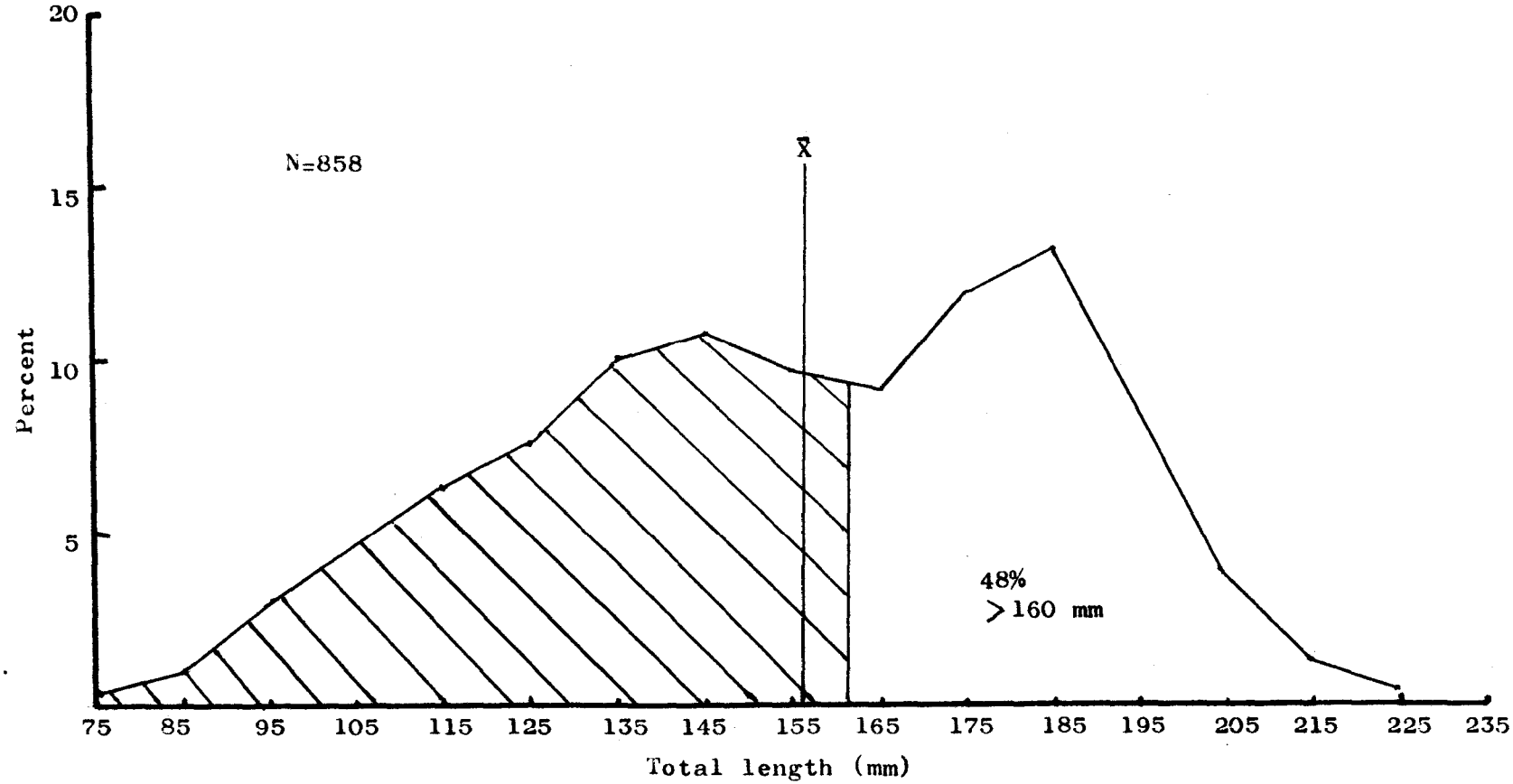

Figure 3. Length frequency of Age I steelhead released from north pond, May 1975.

We graded both raceways of the 1975 brood-year steelhead during the third week of August and moved 220,000 top-grade fish, 72 mm and 290/kg, to the north pond for rearing until released in the spring of 1976. The remaining middle and bottom-grade fish are presently (September 1975) being held in the raceways awaiting regrading and ponding in early October.

Feed Experiment - 1975

Between April and July 1975, we conducted a feed experiment contrasting Oregon Moist Pellets (OMP) to dry diets (Rangen and Silver Cup). This was a continuance of experiments started in 1974 (Mate 1974). We loaded each raceway with approximately 355,000 steelhead fry and used straight spring water for rearing. The fish were fed at recommended levels and intervals but we decreased the recommended size of feed by one size.

The first, and probably most important, difference noticed between the raceways was the initial feeding behavior. The OMP fish started feeding first and displayed more aggressive feeding activity than the dry diet fish. This may be partially explained by the OMP starter mash floating for a longer period after feeding, allowing the fry to feed nearly continuously from one feeding to the next. The dry diet starter floated 10-20 minutes only. We moved the fry to the raceways at 4,136/kg. Three weeks later the OMP fish were 3,274/kg and the dry diet fish 3,590/kg. This was a significant difference in growth and it occurred at a critical period for the fish.

The number of mortalities and "pin heads" was larger among the fish fed dry diet, during May, than among the OMP fish (Fig. 4). We feel this is due to feeding behavior since "pin heading" is often caused by starvation which appears to start during the first 3 weeks of raceway rearing. By the end of June, the OMP fish averaged 585/kg, with total losses to this date at 4.7% for the OMP fish and 6.3% for those on dry diet.

Early in July, the fish in the north raceway (OMP) developed a systemic bacterial infection, possibly from poorly pasteurized feed, followed by Bacterial Gill Disease. The fish in the south raceway remained healthy. Comparisons beyond this time were confounded by 2 factors. First, the OMP fish went "off feed" and remained nonfeeding for 3 weeks as mortalities climbed to a peak of 10,000 per day. Secondly, we were unable to obtain OMP with terramycin added and had to feed Silver Cup TM, a dry diet, to both raceways for 2 weeks.

By early August, all the fish were again healthy and feeding well but the fish on the dry diet were larger than the OMP-fed fish. We graded both raceways in August and ponded 67,000 top-grade fish from the north raceway and 155,000 top-grade fish from the south raceway. Removing the top-grade and mixing the bottom-grade fish terminated the experiment (Fig. 5).

Considering the data from the 1974 and 1975 feed experiments, it appears that at this station Oregon Moist Pellets is a superior feed in starting fish to feed and up to the time the fish reach about 650/kg. After this point, the superior growth of the fish on OMP is offset by the convenience and lower cost of dry diets. This observation comes after only 2 repetitions of the

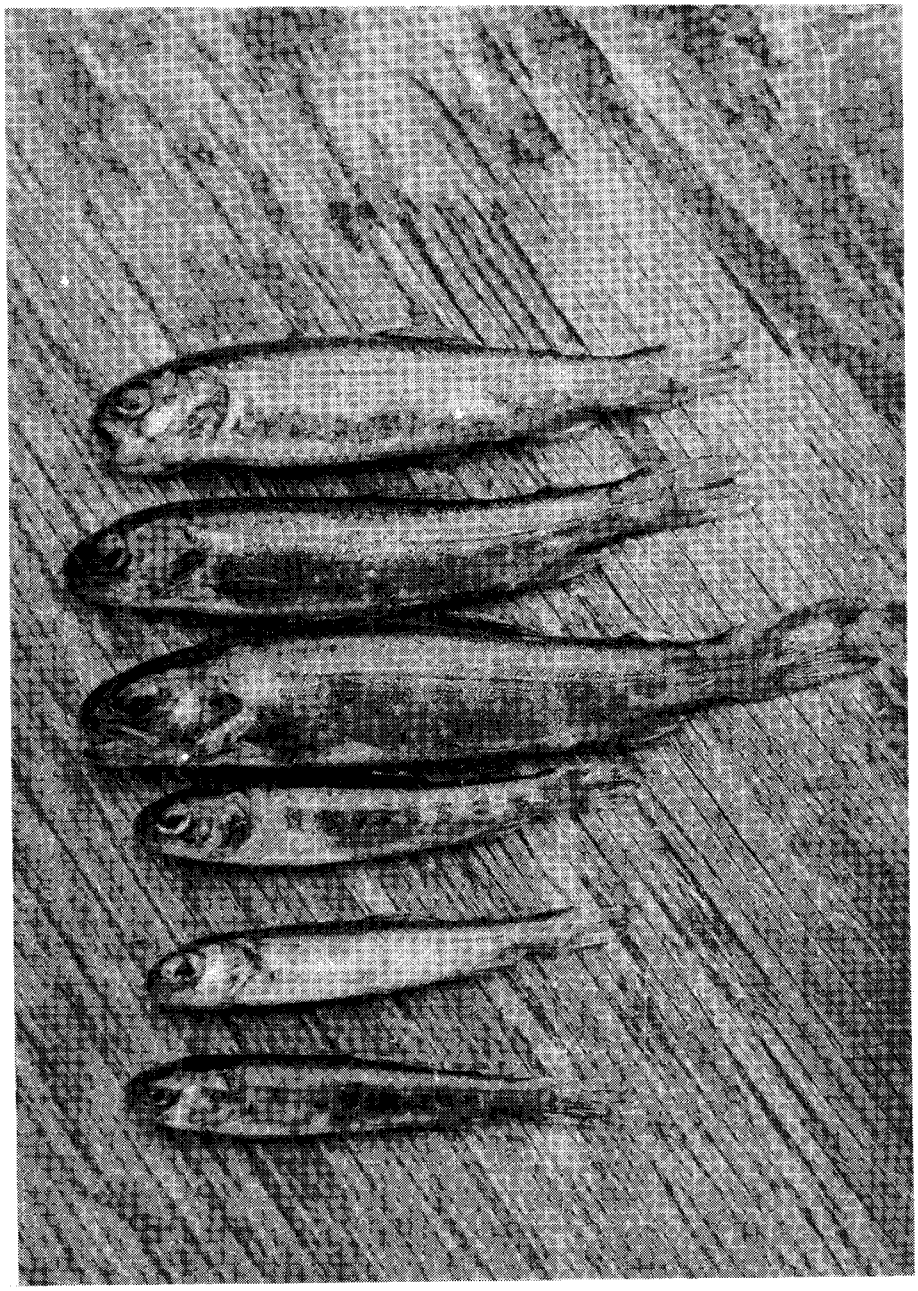

Figure 4. Pinheads (bottom fish) were more common among the steelhead fed dry diet than among the fish fed Oregon Moist pellets.

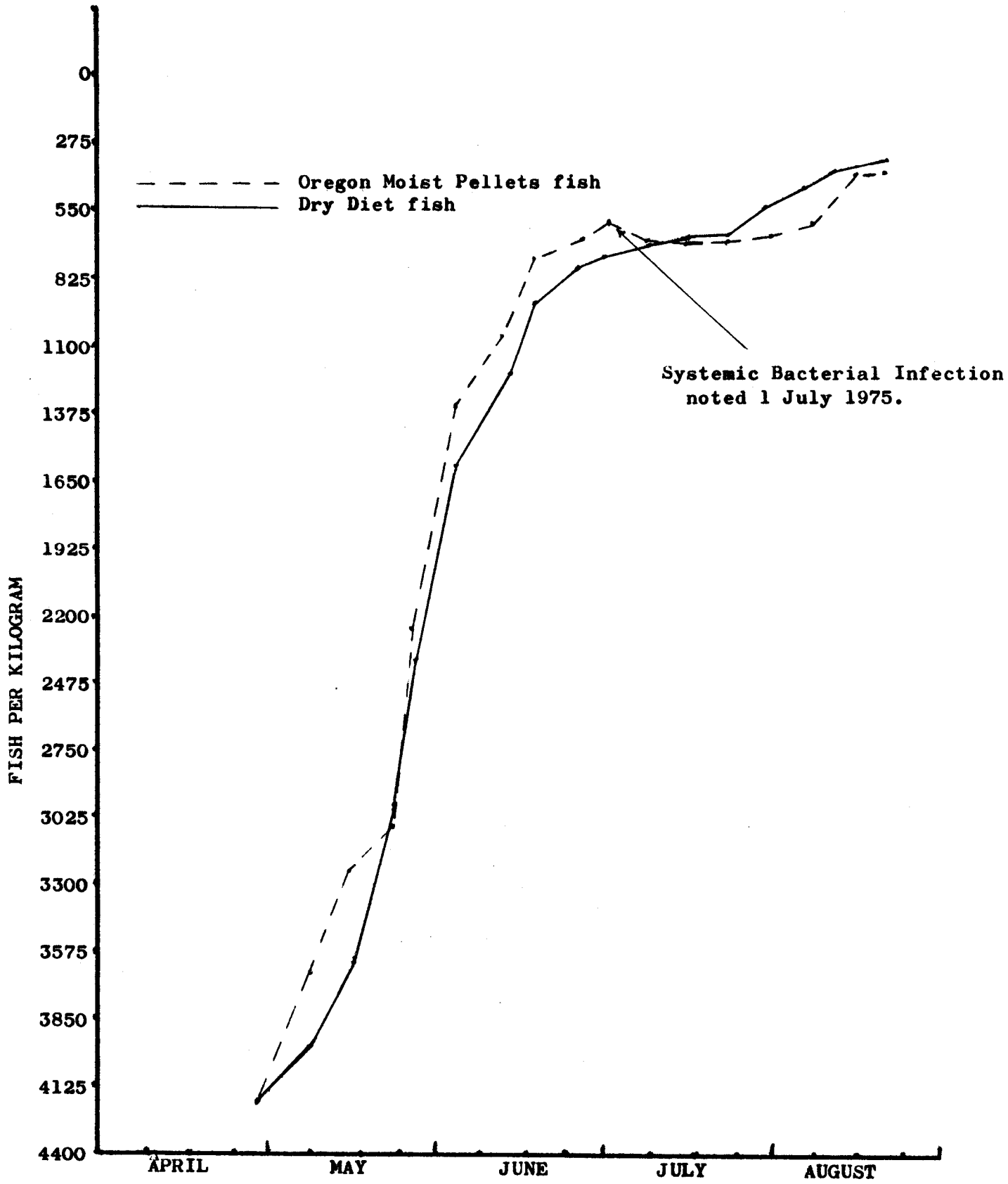

Figure 5. Growth rates of steelhead fed Oregon Moist pellets (OMP) and dry diets show growth benefits for OMP-fed fish until the fish reached 650/kg.

experiment and yet lacks the degree of confidence necessary to alter rearing regimes at this time. We feel that more research is necessary at this station and also at other stations involved in steelhead production.

Discussion - Steelhead

The release this spring of 1 pond of Age II steelhead and 1 pond of Age I steelhead affords the opportunity of a direct comparison of the 2 most used rearing regimes. For the first time in the operation of this hatchery, we will be able to compare adult returns without the confounding factors of annual changing downstream passage problems as they affect both smolts and adults. Analysis of the numbers of returning adults in 1977 and 1978 should indicate the relative advantages and disadvantages of the different rearing cycles.

While continuing to evaluate the releases and returns of Age II smolts, our emphasis is shifting to rearing a 160 mm smolt in 1 year. We hope to accomplish this by obtaining the earliest eggs possible including trying different stocks of steelhead than usually enter Idaho waters. We also plan to incubate the eggs at higher temperatures to provide a longer rearing cycle.

Once in the raceways, the fish will receive prophylactic disease treatments and optimum feeding methods. We will continue to monitor growth by weekly sampling. Raceway growth will remain a high priority rearing phase as we continue to refine the procedures and techniques employed there.

Grading has, in the past years, been suggested as a remedy for wide length dispersion at release. Although we consider it valuable to allow earlier ponding and to eliminate small fish during the pre-ponding period, we can no longer assume that it appreciably decreases wide length dispersion at release, as shown in the 1975 releases. It appears that length dispersion occurs during the pond rearing phase whether the fish are graded before ponding or not. More investigation is needed to determine what factors contribute to size variation (Fig. 6).

We addressed the basic question of what physical characteristics identify a smolt from either sub-smolt or precocial male. Presently our primary indicator is total length. Downstream trapping studies in past years on the Lemhi, Pahsimeroi and other streams indicate that total length appears to be a 160 mm minimum for seaward emigration. Other characteristics for smolts include silveriness and deciduous scales, slimness of body giving a smaller coefficient of condition, and absence of parr marks. During the 1975 spring releases, we noted 140 mm and 150 mm fish with the smolt characteristics and which seemed to emigrate although no downstream trapping was done to prove this (Fig. 7).

Disease outbreaks do not occur in sequence or at predictable times. We treat any diseases as they occur except for Bacterial Gill and Costia which appear endemic in the raceways.

SPRING CHINOOK REARING:

North Pond - 1973 Brood Year - Released September 1974

On 17 September 1974, we released 350,000 spring chinook smolts into

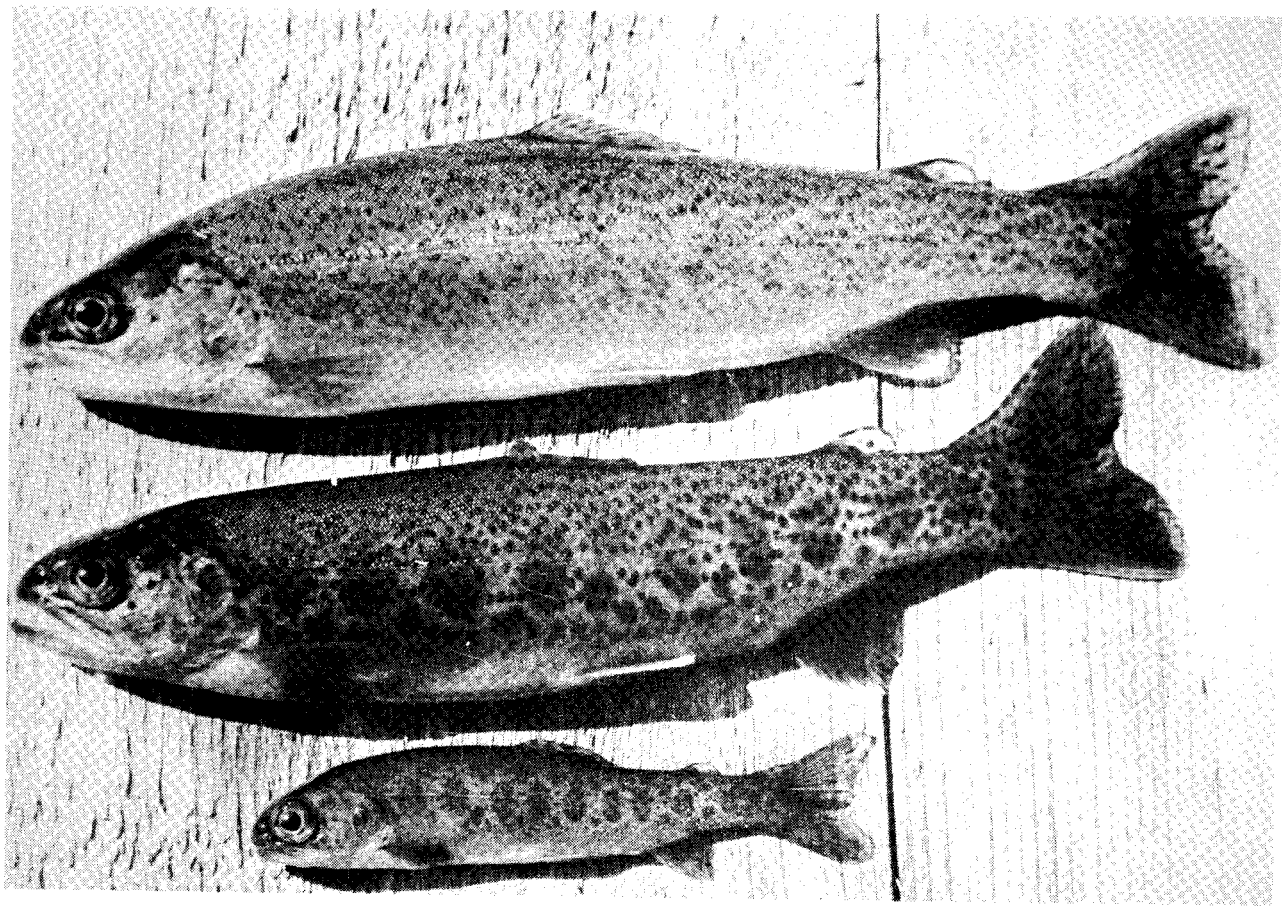

Figure 6. The 1973 brood year steelhead released from the south pond consisted of 52% smolts (top), 6% precocial males (center), and 42% sub-smolts (bottom). The 1974 brood year release from the north pond consisted of 48% smolts and 52% sub-smolts. The percent of smolts was similar.

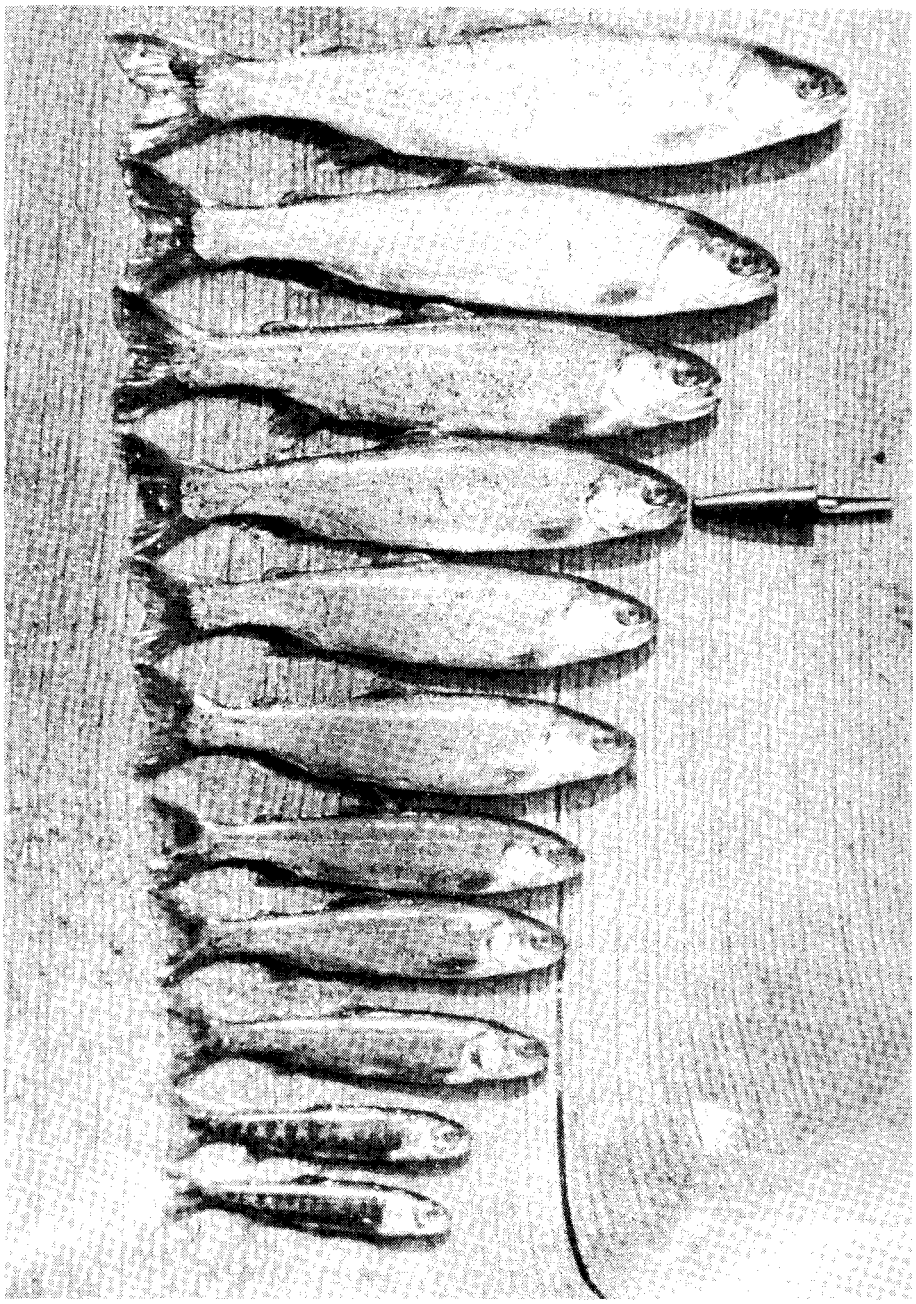

Figure 7. Age II steelhead released from the south pond. Marker indicates 160 mm fish. Smolt characteristics appear in smaller fish also. Even with intensive grading, wide length dispersion was evident at release.

Hayden Creek. These fish averaged 71/kg and 96 mm fork length. We released the chinook 3 weeks earlier than usual to allow ponding of the steelhead; as a result, the fish remained in Hayden Creek, near the hatchery, for almost a month before beginning the downstream migration. This was our fifth fall release of Age I spring chinook smolts from Hayden Creek.

Our egg source for the chinook rearing program is Rapid River Hatchery which provides eyed eggs in September of each year. We incubate the eggs in Heath incubator stacks on Hayden Creek water which varies in temperature from 0-7 C (32-45 F).

Hatching occurred in late November 1973, and we moved the fry to the raceways in early February 1974. We hand fed Oregon Moist Pellets throughout the raceway phase of rearing, converting to dry diet immediately before ponding early in May. We administered prophylactic formalin treatments monthly to the fish, while they were in the raceways, to prevent buildup of the external gill parasites Costia and Tricodina.

South Pond - 1974 Brood Year - For Release October 1975,

Presently (September 1975) we have on hand about 280,000 spring chinook scheduled for release as smolts in October 1975. The chinook averaged 50/kg and 115 mm fork length on 1 September 1975.

In addition to the chinook being reared for release into Hayden Creek, we provided 400,000 fingerlings for the Decker Pond project. The costs of this program were paid for with Dingell-Johnson funds.

We received eyed eggs from the Rapid River Hatchery in late September 1974, and started incubation using straight Hayden Creek water. We mixed in spring water to speed development when we finalized arrangements to obtain the very early steelhead eggs from the Skamania Hatchery. The fish reached the button-up stage the second week of February and we moved them directly to the raceways where we fed Oregon Moist Pellets. We held the fish in straight spring water, 11-13 C (52-55 F), until mid-April when we ponded the fingerlings to make room in the raceways for the steelhead fry. We ponded the chinook at nearly 600/kg, a size we found too small for good adaptation to the pond environment. More fish than usual failed to start feeding at the Neilsen feeders, resulting in a larger length dispersion and also a group of fish that have not shown any length gain since ponding.

We continued with prophylactic treatments for gill parasites during raceway rearing. During pond rearing, the fish were fed dry diet.

Discussion - Chinook

Pond rearing of spring chinook smolts at Hayden Creek has proven itself successful for the fifth straight year. Unusually rapid growth and good seaward emigration are observed at the fall releases. The 1-year rearing cycle produces large numbers of high quality smolts with low numbers of runts or mortalities.

It may be desirable to experiment with raceway densities, feed types, and

parental stocks in future years to obtain maximum releases with the facilities and finances available.

Diseases and timing of outbreaks is more predictable with chinook than with steelhead. We note buildups of Costia and Tricodina on the gills of the chinook in the raceways if we do not treat with formalin every 3-5 weeks. These infestations rarely cause mortality but usually reduce growth and vigor of the fish. We expect the presence of Gas Bubble Disease, as indicated by exopthalmus, about the middle of July if the fish are held in straight spring water. We can eliminate the problem by adding Hayden Creek water if it has cleared and warmed sufficiently from spring runoff.

Commonly, during late August, we observe fish with a grayish coloration starting at the base of the dorsal fin. The coloration may spread to cover 70-80% of the body but we note no signs of distress among the affected fish. This coloration may appear on as much as 10% of the population before it disappears leaving the fish apparently unharmed.

ADULT RETURNS:

Steelhead - 1975

Between 10 March and 15 March 1975, 4 adult steelhead entered the trap at the Hayden Creek Research Station (Table 1). One fish displayed a left ventral fin clip received as a juvenile upon release in April 1973. One fish carrying a left ventral fin clip was also captured at the Lemhi adult trap. This 2-ocean fish was marked in March 1972. All 4 of the adult returnees to Hayden Creek showed deformed dorsal fins indicating hatchery origin. Length of the adults ranged from 610-889 uiut (24-35 in).

We spawned 3 females for a total egg take of nearly 12,000 eggs. Approximately 80% of these eggs reached button-up and were released into Hayden Creek. In addition to the eggs taken at Hayden Creek, in mid-March we received 732,000 eyed eggs from the Skamania Hatchery.

Spring Chinook

A total of 151 spring chinook adults returned to the trap at Hayden Creek between 11 July and 4 September 1975.(Table 2). Seven of the adults displayed right ventral/left maxillary clips received as juveniles in October 1972. We classed 27 of the returning adults as 1-ocean fish, 120 as 2-ocean fish and 4 as 3-ocean fish or older. As spawning time approached in late August, we noted considerable numbers of adult chinook starting redds adjacent to the hatchery. As the natural run of chinook in Hayden Creek is very small, we must assume hatchery origin for these fish. Redd counts conducted on Hayden Creek from Basin Creek to the mouth disclosed 28 redds. This compares to a 5-year (1969-73) average of 5 redds. While counting redds in this section we observed that nearly all available spawning gravel contained redds. We also surveyed upper sections of the stream for spawning activity. We found an additional 43 redds in upper Hayden Creek and Bear Valley Creek, a tributary to Hayden Creek. Assuming 2 adults per redd,we calculated that 142 adults bypassed the ladder at the hatchery and spawned naturally.

Table 1. Summary of steelhead smolt releases and adult returns to Hayden Creek Research Station since initiation of the program in 1966.

Brood year	Year released	Number juveniles released	Number marked	Mark used	River race	Number adults returned as: One-ocean fish	Number adults returned as: Two-ocean fish
1966	1967 (May)	180,000	22,800	LV	Clearwater	48 (1969)	46 (1970)
1967	1968 (May)	340,000	12,000	LV			
			11,700	LV AD	Snake	8 (1970)	10 (1971)
1968	1969 (May)	87,500	26,700	LV			
				L Brand	Clearwater	5 (1971)	6 (1972)
1969	1970 (May)	187,400	55,000	LV	Clearwater, Lemhi 1969 return	11 (1972)	15 (1973)
1970	1971 (May)	72,000	38,000	LV	Lemhi Weir, 1970 return	5 (1973)	17 (1974)
1970	1972 (Mar.)	87,500	50,000	LV	Lemhi Weir, 1970 return	3 (1974)	2 (1975)
1971	1973 (Apr.)	31,700	13,800	LV	Lemhi Weir, 1971 return	2 (1975)	__ (1976)
1972	1973 (Nov.)	47,000	0	--	Lemhi Weir, 1972 return	__ (1976)	__ (1977)
1973	1974 (Apr.)	80,000	80,000	Tetra-cycline	Clearwater	__ (1977)	__ (1978)
1973	1975 (Apr.)	140,000	0	Tetra-cycline	Clearwater, Hayden Creek	_ (1978)	_ (1979)
1974	1975 (May)	89,000	0	--	Clearwater	+ (1978)	_ (1979)

Table 2. Summary of spring chinook smolt releases and adult returns to Hayden Creek Research Station since initiation of the program in 1969.

Brood year	Year released	Number juvenile released	Number marked	Mark used	River race	Number adults returned as: One-ocean fish	Two-ocean fish	Three-ocean fish
1969	1970 (Oct.)	83,200	25,200	AD	Lemhi Weir	0 (1972)	20 (1973)	3 (1974)
1970	1971 (Oct.)	201,000	52,000	½/D, AD, LV	Rapid River	10 (1973)	7 (1974)	4 (1975)
1971	1972 (Oct.)	312,000	73,000	RV, L Max	Rapid River	38 (1974)	120 (1975)	__ (1976)
1972	1973 (Oct.)	151,000	0	--	Rapid River	27 (1975)	__ (1976)	__ (1977)
1973	1974 (Sept.)	350,000	0	--	Rapid River	__ (1976)	_(1977)	__ (1978)

We spawned 55 female chinook for a total egg take of 218,000 eggs. The eggs are currently incubating in straight spring water at Hayden Creek.

Discussion - Adult Returns

The number of adults returning from smolt releases determines the degree of success for the rearing operation. At the Hayden Creek Research Station, adult steelhead returns continue at a very low rate. Adult chinook returns are better. Counting 4-year old returnees, jacks which returned in 1974, and 80% of the adults that bypassed the station, we calculated an adult return of 0.096% of the smolts released in 1973. (This does not include 3-ocean adults due to return in 1976.) We feel that the low steelhead return percentages may be partly explained because of unidentified or unsolved problems inherent in the station's facilities or procedures. However, other problems must be assumed because of the high quality of the smolts released.

In 1975, we estimated nearly one-half of our adult chinook returns bypassed our ladder. Adult steelhead return during the spring runoff period when it is very difficult or impossible to observe adults bypassing the station. We planned a temporary weir for 1975, but unusually high water prevented installation. We plan on weiring the stream in years in which runoff allows. By capturing all the adults, we can more accurately assess the return percentages.

LITERATURE CITED:

Mate, Steven M. 1974. Experimental rearing of anadromous fish, Lemhi River drainage, Idaho. July 1, 1973-June 30, 1974.

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